MULTIPLE WAY SWITCH ASSEMBLY AND SWITCH MODULE

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation of International Application PCT/EP02/11499, published in German, with an international filing date of October 15, 2002, which claims priority to DE 101 51 603.7 filed on October 18, 2001.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a multiple position switch assembly having at least two switch modules. The present invention also relates to a switch module for use in a multiple position switch assembly.

2. Background Art

In many applications such as motor vehicle manufacture, multiple position switch assemblies operate movable components. Such switch assemblies have a multi-function operator control operate which is, for example, cap-shaped, and can be moved in multiple directions. In order to facilitate operation, it is preferable for each of the motion directions of the movable component to be associated with an analogous movement direction of the operator control.

Such switch assemblies are used in the form of two-position switch assemblies in which the operator control has two opposite directions of operation, for example in order to raise and lower a window. Alternatively, such switch assemblies are used in the form of four-position switch assemblies in which the operator control has two pairs of opposite directions of operation which cross one another, for example in order to perform the XY adjustment of a mirror or the adjustment of a vehicle seat.

U.S. Patent No. 6,084,189 discloses a multiple position switch assembly having a dome-shaped switch mat associated with a base. During adjustment, the switching elements of the dome-shaped switch mat are affected by a common actuator connected with an operator control. The operator control is mounted to tilt about several axes.

Relatedly, U.S. Patent No. 5,468,924 discloses a multiple position switch assembly which has four plunger-like control elements concentrically arranged in a base and held so that they can slide. The control elements can be adjusted by a common actuator that can be moved by a centrally arranged operator control. The operator control is mounted to tilt. The control elements act on the switching elements of a dome-shaped switch mat associated with the base.

Further, U.S. Patent No. 5,631,453 discloses a multiple position switch assembly made in the form of a four-position rocker switch. Four lever-like control elements are mounted in a base so that they can pivot. The control elements cooperate with the switching elements of a dome-shaped switch mat. A common actuator which is actuated by an operator control that is mounted to tilt in several axes controls the control elements.

These known switch assemblies have the disadvantage that they use a comparatively large number of individual parts, some of which are complicated to produce, which have to be specially tailored to the application in every case, and which require relatively great effort to assemble. Moreover, all the above-mentioned multiple position switch assemblies have the problem of not being modular and thus the space requirements always have to be tailored to the maximum determined by the functionality.

Moreover, U.S. Patent No. 5,719,361 discloses a switch module having a dome-shaped switch mat arranged in a base. The base has two control elements on it that are associated with the dome-shaped switch mat. The control elements can move in opposite directions and can be alternately controlled by an operator control that can move in opposite directions. However, it is not easy to

produce a four-position switch assembly by adding another such switch module to the original switch module, at least not by adding an a switch module nearly identical to the original switch module.

U.S. Patent Application No. 2001/013464 discloses a switch module in which a base has an operator control mounted thereon. The operator control is adjustable in several directions and has associated control elements. Each control element cooperates with a switching element that is made in the form of an axially movable slide. Each slide has a control bevel that cooperates with a respective switching element. Such a switch module has the problem that its design is quite complex as always being aimed at the maximum functionality.

SUMMARY OF THE INVENTION

An object of the present invention is to provide a multiple position switch assembly which is compact and has as many prefabricated subassemblies as possible with each such subassembly being simple and versatile to produce. Another object of the present invention is to provide an easy-to-produce switch module which can advantageously be used as a prefabricated subassembly in a multiple position switch assembly in accordance with the present invention.

The multiple position switch assembly in accordance with the present invention includes at least two switch modules. Each switch module can be actuated by an actuator that can move in opposite directions. When considered individually, each switch module forms a two-position subassembly for a two-position switch assembly. However, the switch modules are designed in such a way as to be combined in order to form a four-position subassembly for a four-position switch assembly. An actuator common to the switch modules can actuate the switch modules. In order to be combined, the switch modules are of the same kind but are preferably designed to be complementary to one another. The common actuator can preferably be moved in four directions arranged in the form of a cross.

The switch modules each have at least two control elements which are preferably levers. The control elements are associated with one another in pairs by the common actuator and are arranged on a common base in an antiparallel arrangement. The actuator is movable in opposite directions, which subtend an angle (preferably 90°) with the longitudinal extension of the control elements. An associated operator control such as a knob or a button is coupled to the actuator. Preferably, the operator control is rigidly connected with the actuator.

Each control element has at least one associated switching element. The switching element may be contained in the switch module, may be detached from the switch module, or may be fastened to another part of the switch assembly containing the switch module.

The switching elements can be made in various ways such as in the form of elastic contact elements, corresponding to the elastic contact elements of a dome-shaped switch mat which cooperate with associated mating contacts on a circuit board, for example; in the form of prefabricated microswitches, spring switching contacts; but also in the form of switching elements working in a contactless manner, such as, e.g., light barriers, Hall generators, or similar things (in which case an additional (elastic) element might be required to produce the tactile properties and or the force component necessary for return to initial position).

The versatility of the switch module is made possible by the special design and arrangement of the control elements and the base. As indicated above, in addition to using the switch module for a two-position switch assembly with an actuator having an opposite direction of operation, it is also possible to use the switch module in combination with a second switch module of the same kind for a four-position switch assembly in which the actuator has four directions of operation arranged in a cross. For special uses, it is also possible to design the switch module in such a way that its directions of operation are other than the perpendicular pairs of opposite directions.

It is preferable for the switch module to be made of one or more different plastic materials -- two, for example -- using injection molding. In an especially advantageous embodiment of the present invention, the control elements are pivoting levers connected with the base through an axle connection.

In this embodiment of the articulated connection, it is also favorable for the control elements and the base to be produced in one and the same injection molding tool using a multi-component injection molding technique which involves injecting the control elements in bearing receptacles molded on the base. Suitable selection of the plastic materials, especially with regard to the relative shrinkage of the individual materials when they harden, keeps the axle that is molded onto the control element so that it is able to rotate in the associated bearing receptacle almost without play. Moreover, it is also possible to build other moving parts (in particular, a lever-like actuator) into the switch module by the multi-component injection molding technique. This makes it possible, at least to a large extent, to eliminate assembly work.

The multiple position switch assembly in accordance with the present invention having two switch modules, as well as the switch module according to the present invention, are explained in detail below using schematically presented sample embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1a illustrates a first switch module in accordance with the present invention;

FIG. 1b illustrates a second switch module in accordance with the present invention in which the second switch module is identical to the first switch module but for being complementary to the first switch module;

FIG. 1c illustrates the first and second switch modules combined into a four-position switch assembly in accordance with the present invention;

FIG. 1d illustrates top and side views of a switch module in accordance with an alternate embodiment of the present invention in which this switch module has two slide-like control elements;

FIG. 2 illustrates the four-position switch assembly having an actuator and switching elements in accordance with the present invention;

FIG. 3a illustrates an exploded view of a four-position switch assembly in accordance with an alternative embodiment of the present invention in which the switch assembly has two complementary switch modules; and

FIG. 3b illustrates an assembled view of the four-position switch assembly illustrated in FIG. 3a.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

FIG. 1 illustrates an individual switch module 1 in accordance with the present invention. Switch module 1 has a single-piece base 1a. Base 1a can be imagined as being subdivided into three areas: first area I, second area II, and connection area III. First and second areas I, II are located where respective control elements 1b are located, and connection area III bridges first and second areas I, II.

First and second areas I, II, which are where control elements 1b are located, accept articulated connections 1c, as well as – preferably – receptacles 1d or fixing parts for the switching elements. It is preferable if the outer contour of base 1a essentially follows the projection of the respective control element 1b onto base 1a in these areas.

In the sample embodiment shown, articulated connection 1c is in the form of an axle connection. For this purpose, base 1a has molded bearing receptacles for control elements 1b. An alternative embodiment of the articulated connection would be a film hinge, for example. In such an embodiment it is

expedient for control elements 1b to be connected with base 1a, preferably as a single piece.

In the sample embodiment shown, receptacles 1d are provided for switching elements, which are in the form of elastically movable contact elements. The switching elements can be part of the switch module.

In the sample embodiment shown, first and second areas I and II are connected by two bars 1i. However, an alternative plate-shaped connection is also conceivable.

In a two-position switch assembly the two control elements 1b of a (single) switch module 1 can be mechanically linked, for example with a T-shaped actuator mounted so that the actuator can pivot, forming a subassembly for a two-position switch assembly. FIG. 1a indicates the opposite directions of operation of the actuator or operator control (not shown here) as a dashed double-headed arrow labeled "BR".

FIG. 1c illustrates the possibility of combining switch module 1 with a second switch module 1'. Second switch module 1' is the same kind as first switch module 1, but is complementary to the first switch module. In order to combine second switch module 1' with first switch module 1, the second switch module is put against base 1a in the connection area III.

FIG. 1b illustrates second switch module 1' which, as indicated above, is nearly identical to first switch module 1 but is complementary to the first switch module. The opposite directions of operation "BR'" of the actuator or operator control (not shown in FIG. 1b) are indicated as a dashed double-headed arrow. Both switch modules 1, 1' have a geometric shape with a point of symmetry P, relative to which they essentially have point symmetry when the respective base 1a is viewed from the top.

Switch modules 1, 1' are designed so that first switch module 1 combined with second switch module 1' rotated by about 90° forms a compact, four-position subassembly B for a four-position switch assembly. FIG. 1c illustrates the switch modules 1, 1'combined into a four-position subassembly (the associated, directions of operation BR, BR' of the actuator, which are arranged in a cross relative to one another, are drawn in as dashed double-headed arrows). It is preferable for the four-position subassembly B formed in this way to have an essentially square shape, with the four control elements (1b, 1b') being oriented along a specified direction of rotation.

The two switch modules 1, 1' shown in FIGS. 1a, 1b differ only in the design of the respective bases 1a, 1a' in the respective connection areas III. Preferably, this makes them complementary to one another so that combining switch modules 1, 1' produces a flat subassembly, in which control surfaces 1g, 1g' of control elements 1b, 1b' lie essentially in one plane and the base surfaces of bases 1a, 1a' lie essentially in one other plane.

To accomplish this, base 1a' is kept level in connection area III of second switch module 1', while base 1a in connection area III of first switch module 1 has an offset corresponding to the thickness of base 1a' in connection area III of the second switch module. To make the two switch modules 1 and 1' fit together when they are combined, connection bars 1i of base 1a additionally have fitting strips 1k on them.

In passing it should be noted that the design of first switch module 1 with lever-like control elements 1b does not in any way represent the only possible embodiment. For instance, FIG. 1d illustrates top and side views of a possible alternative design of first switch module 1. In this embodiment, control elements 1b are slides instead of levers, and are arranged so that they can slide axially on an essentially plate-shaped base 1a. Further, in this embodiment, slides 1b extend parallel to one another in the longitudinal direction, with the slides alternately acting on switching elements 3a which are arranged so that their direction of operation is horizontal.

In this sample embodiment switching elements 3a are realized by the contact elements of a dome-shaped switch mat and are arranged on extensions 11 of base 1a that are bent vertically upward. It is possible to identify the moving (switching) contact 3d (in particular a "dot"), which is held by a cone-shaped, elastic hollow body 3e, made, in particular, of silicone. Pressing on the switching contact (see arrows in FIG. 1d) brings switching contact 3d in contact with stationary contacts which are present (not shown in FIG. 1d) on extensions 11. The slide-like control elements 1b are (corresponding to the embodiment described above) controlled by an actuator 2 (not shown in FIG. 1d) which can move in two opposite directions of operation. In turn, actuator 2 is preferably perpendicular to the longitudinal extension of the slides 1b.

In particular, actuator 2 can be made in the form of a pivoting lever, whose axis of rotation runs parallel to the longitudinal extension of slides 1b. Each of slides 1b has a control surface 1g in the form of a control bevel; the bevels of the respective slides lie opposite one another. This makes it possible for actuator 2 to actuate slides 1b – and through them the switching elements 3a – alternately in the horizontal direction (i.e., parallel to the surface of base 1a) by applying vertical pressure to the control bevels 1g.

FIG. 2 illustrates an assembled four-position switch assembly S with first and second switch modules 1, 1' according to the embodiment shown in FIGS. 1a, 1b, and 1c with a possible design for actuator 2. Actuator 2 is mounted in a kind of universal joint so that it can pivot on two perpendicular axes in four directions BR and BR'.

In the illustrated embodiment of the four-position switch assembly S, each of the four control elements 1b, 1b' is respectively associated with one of four individual switching elements 3a, 3a'. It is possible for switching elements 3a, 3a' to be fastened to respective bases 1a, 1a' and/or to respective control elements 1b, 1b' in a positive-locking manner or by joining together the materials of these parts.

It is also possible to build four-position switch assembly S with completely identical switch modules. If the switch modules are made similar to those shown in FIGS. 1 and 2 and if the complementary design of the intermediate area III is abandoned in order to standardize the switch modules, then control surfaces 1g, 1g' of control elements 1b, 1b' no longer lie in one plane, but rather are offset in height according to the material thickness of the intermediate area III. In order to keep this offset of control surfaces 1g, 1g' as small as possible, the thickness of the material in connection area III can be kept very thin and/or connection area III can be made elastic, so that the control elements or the surfaces of the base lie at least approximately in one plane. Alternatively, the offset can be compensated by a corresponding adaptation of the design of actuator 2 and/or of the switching elements 3a, 3a'.

FIGS. 3a and 3b illustrate another sample embodiment of a four-position switch assembly S according to the present invention containing two complementary switch modules 1, 1'. In this four-position switch assembly S, the two complementary switch modules 1, 1' differ in design details adapted to the overall structure of the switch assembly, however the theoretical design of the switch modules is the same.

Each of switch modules 1, 1' in turn has two control elements 1b, 1b' that are arranged antiparallel to one another on the respective base 1a, 1a' and that are connected with them in an articulated manner. It is preferable if the articulated connections 1c, 1c' in turn are axle connections, with it being advantageous for the control elements 1b, 1b' – as already explained – to be injected in respective bases 1a, 1a' using a multi-component injection molding technique (in the same tool).

Actuator 2 of four-position switch assembly S can pivot on two perpendicular axes. Guide pin 2c fastened to actuator 2 can have an operator control (for example, a cap). Actuator 2 includes two internal and external control parts 2a and 2b which are movably connected with one another and which can also preferably be injected inside one another by multi-component injection molding.

Actuator 2 itself is held by another axle connection so that it can rotate in switch module 1 with guide pin 2c being mounted in a universal joint. It is also preferable for this axle connection to be produced by multi-component injection molding so as to produce a subassembly having switch module 1 with actuator 2 movably mounted in the switch module.

Peripheral cams 2d, 2d' are on the bottom of control parts 2a and 2b (FIG. 3a illustrates only one of the four peripheral cams). Two peripheral cams 2d arranged opposite one another on the inside control part 2a cooperate with control surfaces 1g of control elements 1b, and the two peripheral cams 2d' arranged opposite one another on the external control part 2b cooperate with control surfaces 1g' of control elements 1b' (see also FIG. 3b). Also identifiable in FIG. 3a is a fastening element 1f formed on base 1a. This fastening element is in the form of a sleeve, for example, into which a self-threading screw can be screwed, fixing the four-position switch assembly S onto a support, for example.

Bases 1a, 1a' of switch modules 1, 1', respectively are, in connection area III, made complementary to each other according to the groove and spring principle in such a way that control surfaces 1g, 1g' of control elements 1b, 1b' lie essentially in a plane and the base surfaces of the base lie essentially in a (different) plane. In FIG. 3a the "groove/spring" fitting elements are labeled by reference numbers 1e, 1e'.

It is preferable for the switching elements 3a, 3a' associated with control elements 1b, 1b' to be designed as elastic contact elements embedded in a common molded part (the switch mat) that is elastic (e.g., made of silicone). Each contact element includes an elastic, approximately cone-shaped area, which contains an electrical contact, for example, a carbon dot or a contact made of an elastic, conductive composite material. This elastic moving contact can have pressure applied to it by the respective actuator, putting it in contact with the associated mating contact arranged on a circuit board, for example (not shown).

Switch mat 3 has latching means 3b molded on it which cooperate with associated means of mating for the latch (latch receptacles) 1h', so that switch module 1' can be clipped onto switch mat 3 at specified positions.

Also identifiable in FIG. 3b are stop elements 1j, 1j' for control elements 1b, 1b'. Stop elements 1j, 1j' ensure that when the one control element 1b arranged on base 1a is actuated, the other control element 1b is pressed by the associated (elastic) switching element 3a against the corresponding stop 1j, preventing rattling of the control element 1b that has been released.

Together with the inherent mechanical properties of an elastic contact element, which produces a "clicking feeling", suitable selection of the lever ratios of the control elements 1b, 1b' (e.g., position of the center of pressure of peripheral cams 2d, 2d' on the lever-like control elements 1b, 1b') can give the multi-position switch assembly according to the present invention especially advantageous tactile properties.

Another advantage of this four-position switch assembly S is that it makes space-saving use of available space. In the center of four-position switch assembly S a useable free space is produced. In the sample embodiment shown in FIGS. 3a and 3b, an extension 2e of guide 2c passes through this free space. Thus, it is possible for extension 2e to be guided in a link guide (not shown), which is preferably cross-shaped, so that movement of actuator 2 is only possible along specified link paths.

The arrangement can also be designed so that extension 2e passes through switch mat 3 or an associated circuit board (not shown), so that it is also possible to take advantage of the space beneath the circuit board (for this purpose, FIG. 3a schematically shows an opening 3c in switch mat 3).

It is also conceivable for actuator 2 to have other (actuation) functions associated with it, for example extension 2e connected with guide pins 2c can be mounted so that it can rotate and/or move axially in control part 2a, so that it can

execute an additional turning or pushing function. For this purpose, an axially movable extension 2e can be mechanically linked with a push-type switching element (e.g., a micro-switch) which is fastened to the internal control part 2a or on the circuit board. Accordingly, the rotation of an extension 2e mounted so that it can rotate can be converted into a corresponding electrical signal by a rotary potentiometer fastened to internal control part 2c. Moreover, it is possible for the rotational and or pushing motion of the operator control to be converted into a corresponding electrical signal by contactless signal transmitters and/or detectors (e.g., magnets and Hall generators).

Moreover, it is also possible to make advantageous use of the free space to hold illumination elements, for example light emitting diodes, etc. This makes it possible to transfer the state of switching elements 3a, 3a' into the operator control in an optical manner through light-conducting elements located in guide pins 2c and 2e (optical fibers), for purposes of display. It is also possible for internal control part 2a itself to be a light-conducting element.

While embodiments of present the invention have been illustrated and described, it is not intended that these embodiments illustrate and describe all possible forms of the present invention. Rather, the words used in the specification are words of description rather than limitation, and it is understood that various changes may be made without departing from the spirit and scope of the present invention.

List of Reference Numbers

	1, 1'	Switch module
	1a, 1a'	Base
	1b, 1b'	Control elements
5	1c, 1c'	Articulated connection
	1d, 1d'	Receptacles
	1e, 1e'	Groove/spring elements
	1f	Fastening element
	1g, 1g'	Control surfaces
10	1h	Bearing receptacle
	1h'	Latch mating means
	1i, 1i'	Bars
	1j, 1j'	Stops
	1k	Fitting strip
15	1l	Perpendicular extension
	2	Actuator
	2a	Internal control part
	2b	External control part
	2c	Guide pins
20	2d, 2d'	Peripheral cam
	2e	Extension
	3	Switch mat
	3a, 3a'	Switching elements
	3b	Latching means
25	3c	Opening
	3d	Switching contact
	3e	Elastic hollow body
	B	Four-position subassembly
	S	Four-position switch assembly
30	BR, BR'	Opposite directions of operation of actuator or operator control
	P	Point of symmetry

I	First area of base
II	Second area of base
III	Connection area of base